Background

Our work examines the relationship between knowledge/familiarity with shale gas and attitudes towards shale gas industry development in a comparative context. The United States (US) and United Kingdom (UK) represent very different cases of shale gas development. Shale gas development is a relatively mature industry in the US, with extraction via hydraulic fracturing ("fracking") occurring in many shale gas plays (e.g., the Marcellus in the Northeast, the Barnett in Texas, the Bakken in North Dakota, and others). In direct contrast, although the UK does produce a small amount of onshore gas from other reservoir rocks, no extraction of shale gas has yet commenced; fewer than ten test wells (9 to be exact) have been drilled to date in the UK (http://frack-off.org.uk/extreme-energy-fullscreen/).[1] Despite the lack of actual shale gas development, dialogue about shale gas extraction has been no less lively in the UK (e.g., Bomberg 2015; Cotton 2014; Jaspal Williams et al. 2015) than in the US (Ashmore et al., 2016; Evensen et al., 2014; Vasi et al., 2015).

Much of the conversation about shale gas development in the UK has tended to focus broadly on whether it will obtain positive or negative impacts and why (as opposed to how to *manage* specific aspects of development). This conversation, thus, points to whether development should or should not occur (Bomberg, 2015; Jaspal and Nerlich, 2014; Wagner 2015). In the US, mass media discourse and community conversations often focus more frequently on nuances of how to *deal with* perceived positive and negative outcomes (Sovacool, 2014; Stedman et al., 2012) of development than on whether to encourage or resist it. Because the evolution of shale gas development is still relatively early, the UK may have a great deal to learn from the US when considering whether and how to approach shale gas development, although several key differences need to be considered that reflect the different contexts in which development is occurring and/or may occur.

There exist important contrasts between the US and the UK that suggest the need for comparative analysis. These contrasts begin with private, dispersed vs. nationally concentrated ownership of mineral rights. In much of the US, rights to subsurface resources are owned by the

[1] The website is for an activist group, but it is the preferred source of information for the government's Department of Energy and Climate Change (DECC) on this topic

landowner. Especially in the Northeast US, where private land is relatively more abundant than the west, this means that it is quite common for individual private landowners to own the mineral rights. As such, the potential for individual landowners to potentially profit economically from shale gas development is dramatic (see Kinnaman, 2011 for a cogent review). This profit potential is especially salient in contexts of persistent rural poverty. 'Split estates' (where the current or past landowner has sold the subsurface rights) are also relatively common (Anderson, 2013), especially in the South and Midwest. There also has been substantial development on government land—these government bodies then own the mineral rights in these contexts, and may enact additional regulations (Rahm and Riha, 2014). This is especially common in the western US, which is proportionately more dominated by public lands.

The situation is comparatively much simpler in the UK: all mineral rights are vested to the Crown: although individual landowners may still receive some revenues from access fees, their potential economic returns are not of the magnitude found in the US. This key difference can affect views of energy development, as landowners in shale gas extracting regions within the US potentially have much to gain through leasing their drilling rights (Bugden et al., 2016), thus potentially polarizing discourse and also resulting in greater framing of the issue in the US of one as potentially enhancing the well-being of rural people and communities in shale gas regions (e.g., Braiser et al., 2012; Considine et al., 2010). While these economic benefits are far from agreed-upon (Schafft et al., 2013; Muehlenbachs, 2015), the point we wish to emphasize here is that the *potential* for these benefits has affected the discourse surrounding shale gas development (Fry et al., 2015) in a way that differs from the UK.

This difference in ownership also means that mineral rights are leased in a highly decentralized manner in the US (Fitzgerald, 2010; Warner et al., 2013) with myriad individual landowners (or coalitions of landowners, see Jacquet and Stedman, 2011) making decisions across time and space. The opposite occurs in the UK, where leasing happens at the national level and is conducted by the government via awarding of licenses covering vast areas. This latter point will be re-engaged below. Accompanying and complementing this decentralized leasing in the US is fragmented governance (Small et al., 2014). In the US, states retain the majority of control over regulation; some have granted municipalities varying levels of oversight

over development (e.g., Pennsylvania) while others have retained all governance capacity centrally (e.g., Ohio). In the UK, with the exception of devolved powers to the Scottish Parliament, Parliament in Westminster has the ultimate authority over regulation. [2]

Governance has further shaped the stage on which shale gas-related discourse has played out. As with ownership and governance, discourse has occurred much more at a national level in the UK compared with the US (Cotton et al., 2014; Williams et al., 2015). The plurality and diversity of regulations in the US has fostered much more regionally-centered discourse in areas exposed to development or with the potential for development. Also contributing to this relationship is the nature of the media: the print media in the UK it is overwhelmingly national, compared to viable local/regional print media in the US. Coupling this with the potential for rural development impacts of shale gas development has resulted in shale gas emerging as a very salient local/regional issue by local/regional/rural media (Ashmore et al., 2016; Evensen et al., 2014; Theodori et al., 2014) in the US.

In contrast, Williams et al. (2015) suggest that UK institutional actors have helped to create a more centralized discourse "…in which the policy approach is defined through a deficit model of public understanding of science and in which a technical approach to feasibility and safety is deemed as sufficient grounds for good [centralized] policymaking." They suggest (p.4) that this "supports a policy story-line (see Hajer, 1996) in which the sole legitimate barriers to achieving 'real public support' are seen to be a failure on the part of the public to recognise the benefits of fracking and to be reassured by institutional commitments to effective risk assessment and management." In this vein, Whitmarsh et al., 2015 (420) note that "The Royal Society (2012) concludes the safety and environmental risks of hydraulic fracturing are low and manageable through best practice and enforcement of UK regulations. They also recommend understanding public acceptability of shale gas extraction and use in the context of energy, environmental and economic policies be considered a priority for UK research."

In the UK, the science underlying hydraulic fracturing is seen as essentially sound; what is lacking is public recognition, understanding, and acceptance of this well-established, centrally

[2] Wales is also seeking authority to self-regulate shale gas development

produced science. The implicit (at times explicit) framework here is that greater understanding will promote greater acceptance. Whitmarsh et al. continue, stating that the Royal Society also prioritizes understanding and fostering public acceptability of shale gas extraction and use. Similarly, the International Energy Agency concludes shale gas operators require a 'social license to operate' (see also O'Hara et al., 2014). Specifically, one key goal of the UK Office of Unconventional Gas and Oil (OUGO) is to 'support public engagement', described as 'helping people understand the facts about unconventional gas and oil production and what it could mean if it takes place in their area' (DECC, 2013). Williams et al., (2015) continue (p.4): "The UK Prime Minister David Cameron adopted this rhetoric when he suggested that '[i]f neighbourhoods can see the benefits – and are reassured about its effects on the environment – then I don't see why fracking shouldn't receive real public support' (Cameron, 2013). Cotton et al., 2014 notes that the combination of central government rhetoric and growing grassroots activism makes shale gas a matter of national public policy debate, and notes Cameron's emphasis (2013) in the Telegraph newspaper, stating: "Fracking has become a national debate in Britain – and it's one that I'm determined to win."

Literature Review

Among the myriad comparisons between the US and the UK, which we could address, we focus in particular on the relationship between familiarity/knowledge about shale gas and support/opposition for development of the industry.

Knowledge and Support for Shale Gas: Comparative Studies

There is a well-established precedent for exploring the relationship between knowledge and support for shale gas development and how that relationship varies across contexts. Within the North American context, there has been a robust body of work comparing perceptions of shale gas across states/provinces (Borick et al. 2013; Evensen et al., 2014a; Kromer, 2015; LaChapelle and Montpetit, 2014; Stedman et al., 2012) and within states (Ivacko and Horner, 2014; Kriesky et al., 2013; Theodori, 2012). Our study in particular builds upon previous work (e.g. Stedman et al., 2012; Brasier et al., 2011) that compared views of unconventional gas development across two US states within the Marcellus Shale region: New York, where there

remains a statewide ban on drilling, and Pennsylvania, where drilling has been proceeding for a decade or more. The study (a mail survey) focused only on residents within the Marcellus shale region itself. Stedman et al. 2012, found (p.386) "Despite nearly a decade of gas development in the Marcellus Shale region of Pennsylvania and the associated media coverage, respondents from both states generally reported knowing relatively little about the potential impacts of gas drilling. Moreover, the response patterns of Pennsylvania and New York residents did not differ significantly from one another in their self-assessed knowledge." Respondents in this study also expressed that they knew relatively little about particular elements of development, such as drilling procedures, legal implications of leasing, government regulations, environmental impacts, economic impacts, and other topics. Again, the authors found that Pennsylvania and New York respondents did not differ in their self-assessed knowledge, despite the presumed differences in exposure to the industry. Pennsylvania respondents in this study were also slightly more likely, on the whole, to support further shale gas development (47% vs 41% in New York). Although not willing to suggest a causal relationship between exposure and support, the study demonstrated that exposure to the industry (rather loosely operationalised, however, by residence in an active drilling play, versus not) is *not* associated with greater self-assessed knowledge, but *is* associated with slightly greater support.

At least in a preliminary way, these findings suggest that more exposure does not necessarily lead to greater familiarity/knowledge, thus opening the door to making these comparisons at a broader scale: across nations. An even more recent study in the UK (Whitmarsh at al., 2015), although not explicitly comparative across regions, echoed the policy rhetoric described earlier, finding a positive relationship between knowledge about shale gas development and positive attitudes/support for development. The researchers varied information experimentally and found that providing additional information to respondents was associated with more positive attitudes, regardless of whether the information was framed in positive or negative terms.

Knowledge and Support of Risky Technology: The Information Deficit model and its discontents.

Our review concatenates previous work on the relationship between knowledge and support of potentially risky technologies such as shale gas development. Industries such as

unconventional gas development can be framed as technological risks (Fischoff et al., 1978; Freudenburg and Pastor, 1992; Slovic, 2000, see Zoback et al., 2010 for an explicit framing of shale gas development in this vein). Often, responses to technological risks, particularly oppositional responses, are analyzed as properties of individuals: i.e., through their use of heuristics (Tversky and Kahneman, 1974; Freudenburg, 1992), or emotion (Slovic et al., 2004). Commonly, overcoming public opposition to such technological risks is thus seen as accomplished via cognitive-based models whereby attitudes are changed via the provision of information (Slovic et al., 2000). This has come to be known as the "information deficit" (Gross, 1994; Miller, 2001; Sturgis and Allum, 2004) or "educating the public" (Heberlein, 2012) model, whereby the provision of information about the risky technology or scientific enterprise is thought to allay concerns and generate support among a previously "irrational" public (Wandesman and Hallman, 1993). Additional information, so the logic goes, helps to reduce this supposed irrationality. This model therefore implicitly (or even explicitly) asserts that attitudes are based primarily on information, are relatively easy to change with the provision of additional information, and are tightly linked to relevant behavior (Heberlein, 2012).

Miller (2001) asserts that that the deficit model fails to deliver on its promises. Sturgis and Allum (2004, p.56) note that "the deficit model has come in for sustained criticism on a number of grounds", including the assumption that fear is primarily based on a lack of knowledge, neglecting that risks are given attention based on linkages to cultural assumptions (see Douglas and Wildavsky, 1982); biased measures used to measure knowledge; and the importance of social trust as underpinning risk. Heberlein (2012) confirms that most of the underlying assumptions he reveals regarding the relationship between information, attitudes, and behaviors do not hold up to scientific scrutiny: the public is often not irrational, nor are attitudes easily changed with the provision of additional information, nor are they often strongly related to risk-related behaviors (see also Peters, 2000).

More broadly, numerous challenges have been raised regarding risk perceptions as the properties of individuals (e.g., Douglas and Wildavsky, 1982; Kasperson, 1992; Rayner et al., 1992; Renn et al., 2002; Wilkinson, 2001), but instead are culturally and socially rooted, noting the importance of social agreements in shaping what risks are selected for attention, but also the

importance of social context in shaping these risks. In moving towards what becomes their "contextualist" argument, Sturgis and Allum (2004, p.57) nicely articulate that [although these] "criticisms [of the deficit model] are undoubtedly in many ways valid, they do not, in our view, sufficiently problematize the deficit model to justify scrapping it entirely. Indeed, we find it puzzling that many scholars utilizing survey research methods that consistently uncover associations between knowledge of and attitudes towards science, despite controlling for a range of other important characteristics such as age, education, and social class, often choose to ignore this finding."

Research Rationale, Questions and Methods

Rationale

The contextualist perspective described above provides a solid foundation for our comparative approach to assessing the relationship between knowledge and attitudes. Our engagement is based on our own healthy skepticism for the information deficit model: we agree with many of the theoretical critiques raised above, and note the results specific to shale gas development in the US that also challenge the assumptions of this model. However, a different story seems to emerge in the UK sources engaged herein, where greater knowledge does appear to be linked to greater trust in science and concomitant perceived risk. We have also engaged how the shale gas question appears to manifest differently across the two contexts with respect to policy and media coverage, which—in the UK—appear to be tipped more towards concerted, concentrated efforts to gain increased acceptance. Our research therefore engages the question of how context affects the relationship between, knowledge, and support. We focus herein on the centralized discourse and programmatic efforts in the UK that emphasized educating the public about science in general and about shale gas development in particular. This institutional rhetoric within the UK fits well with the deficit model we engage: central authority in the UK has explicitly adopted an information deficit model that is explicitly pro-science and pro-shale gas. This has been much less the case in the US with more decentralized (regional, state level) governance and no clear central message.

Research Questions

Emerging from the review above, we ask four questions in our work:

1. What is the level of knowledge about shale gas development, and how does it differ between the general population of the US and the UK?
2. What socio-demographic attributes are associated with knowledge?
3. What is the overall level of support for shale gas development, and how does it differ between the general population of the US and the UK?
4. What is the relationship between knowledge and support and how does it differ between the general population of the US and the UK?

Research Methods

Parallel questions were asked on two national level surveys, one each in the US and the UK. Within the UK, the University of (*name removed for blind review)* has been conducting a national survey since March 2012 (see *name removed for blind review*). At the time of our research, the survey had been administered 10 times between then and September 2014, and has allowed tracking of fine scale changes over time. It has been administered through "YouGov" (https://yougov.co.uk/opi/), a panel sampling firm, resulting in nationally representative panel data[3] (with respect to attributes such as gender, age, region, ethnicity, income). The sample size has ranged from ~ 2500 to 3800 respondents per offering (table 1).

Table 1: Administration Dates and Sample Size of UK Survey

Date of survey	# of respondents
18th-20th March 2012	2784
26th-30th April 2012	2791
17th-19th June 2012	2687
13th-14th December 2012	3530
14th-18th March 2013	3697
30th June-2nd July 2013	2126
20th-24th September 2013	3688
22nd-24th January 2014	3751
11th-13th May 2014	3657
9th-11th September 2014	3822

[3] YouGov uses targeted quota sampling as opposed to random probability sampling. The software looks at all surveys that currently need panel members, and calculates how many people to send invites to every 30 minutes. Panel members are selected to meet certain survey requirements regarding sociodemographic characteristics. Sampling frames are drawn according to the population being researched, and will generally contain the same target quotas as desired by the research.

Within the United States, *name removed for blind review* University replicated key questions on the continuing UK YouGov survey conducted in September 2014 as part of a larger survey effort examining national perspectives on shale gas. For our key variables—knowledge and support/opposition--we used the exact wording of the UK YouGov survey to maximize comparability. This study utilized a Qualtrics panel (http://www.qualtrics.com/) of a nationally representative[4] sample (n = 1625) regarding key comparison attributes of age, gender, and state-by-state population distribution.

The items that form the crux of our analysis include the following: *Knowledge* was measured via a multiple choice item "*This is a fossil fuel, found in sedimentary rock normally more than 1000 metres below ground. It is extracted using a technique known as hydraulic fracturing, or 'fracking'. Is this fossil fuel:" a) Boromic gas, b) Coal, c) Xenon gas, d) Shale gas, e) Tar-sand oil, or f) Don't know*. Prior to the US team's involvement (prior to fall, 2014), UK respondents who answered incorrectly or responded that they did not know were excluded from the remainder of the survey. At the request of the US researchers, the UK researchers agreed to change this protocol to retain those who answered incorrectly or stated that they did not know (otherwise, our assessment of the relationship between knowledge and support would be impossible).

Support/opposition was also measured via a single item *"Do you think that extracting natural gas from shale in the [UK/US] should or should not be allowed*?" In the UK, the response options with the a 3 category response metric: <1> Should be allowed; <2> Should NOT be allowed; <3> Don't know. Because attitudes are nearly always more nuanced than

[4] The US survey was not limited to the questions directly comparable between the US and UK but also explored a range of issues within the US. Because shale gas drilling often occurs in places of relatively low population density, a simple random sample would have identified very few individuals living within or near a shale gas play. We were interested in views among Marcellus Shale respondents in particular. As such, our initial sample included an oversample of residents living within the states of New York and Pennsylvania. We recognize, however, that such an oversample reduces our ability to compare the US and UK at a national level. We therefore re-weighted our sample proportionately to account for the oversampling within the Marcellus shale region: Pennsylvania and New York respondents were re-weighted by 0.26 and 0.38, respectively, to account for their relative oversampling proportionate to their representation in the US population.

simple dichotomies, this question was asked on a 5 category scale in the US: *Do you think that extracting natural gas from shale in the United States should or should not be allowed*?: <1> Definitely should be allowed; <2> Probably should be allowed; <3> Probably should NOT be allowed; <4>Definitely should NOT be allowed; <5> Don't know. Following common practice (e.g., Sudman and Bradburn, 1986), the first 4 response options were compressed into 2 categories that matched that those from the UK; "definitely" and "probably" should be allowed were combined into "should be allowed", and definitely" and "probably" should not be allowed were combined into "should not be allowed". This allowed us to preserve the nuance of the attitudinal item for US based study, while maintaining comparability with the response items in the UK study.

As our second research question addressed correlates of knowledge, we relate answering the knowledge question correctly to respondent socio-demographic attributes (e.g., gender, education, political ideology, and others), connectivity to the industry (region of residence, and in the US case, whether one had a lease on his/her property). Although we were interested in the relationship between information sources and knowledge, we were unable to ask directly comparable items across the two surveys: the UK version of the survey only asked questions about what particular print media sources (all UK based) were read in general. Clearly, replicating these items in the US would not have provided useful information, so we only explore socio-demographic correlates.

Results

What is the level of knowledge about shale gas development, and how does it differ between the general population of the US and the UK?

UK respondents demonstrated far higher knowledge (as indicated by answering the item correctly) than US respondents. Among US respondents, 33% answered correctly, 40% said that they did not know, and 27% answered incorrectly (table 2). In the UK, 72% answered correctly, 19% said they did not know and only 9% answered incorrectly.

Table 2. Knowledge Differences between the US and the UK.

	US Respondents		UK Respondents	
	N	**(%)**	**N**	**(%)**
Shale Gas (Correct)	**425**	**33.4**	**2766**	**72.3**
Boromic Gas	22	1.7	37	1.0
Coal	188	14.7	227	5.9
Xenon Gas	23	1.8	26	0.7
Tar-sand Oil	107	8.4	54	1.4
Don't Know	510	40.0	714	18.7

What are the socio-demographic attributes associated with knowledge?

For both the US and the UK, we explore socio-demographic correlates of knowledge. Respondent characteristics were not asked in precise parallel fashion (i.e., categories of income, education, etc. are not identical across the countries). Because of this lack of parallelism, and because it represents a relatively small portion of our analysis, we do not formally compare predictive models across the two study sites. Rather, we explore these relationships via simple correlational analysis. Within the US, answering correctly was positively associated ($p<.05$ for all variables listed below) with being male, older, more educated, having higher family income, living in a region where shale gas development was viewed as a salient topic (as defined by residing in a state with active shale gas development, or in a state [for example, New York] with intense media scrutiny and debate about whether development should move forward). There was also a surprisingly modest, but significant at $p<.05$ relationship ($r=.055$) between knowledge and holding a current oil or gas lease on one's property (table 3).

Table 3. Correlates with Knowledge (answering correctly), US and UK

	US Respondents		UK Respondents	
	Pearson	**Sig (p<)**	**Pearson**	**Sig (p<)**
Gender	-.196	.001	-.126	.000
Age	.073	.01	.081	.01
Education	.185	.001	.142	.001
Income	.102	.001	.116	.001
Political Ideology	-.005	ns	n/a	n/a
Live in shale state	.122	.001	n/a	n/a
Current lease	.055	.05	n/a	n/a

The UK results followed a similar pattern to those observed in the US. Increased knowledge was seen for ($p<.05$, for all relationships listed) older respondents, men, those with more income, and more education (while acknowledging that the particular categories for income and education were not a precise match). Political ideology was not asked in a way comparable to the US (on a conservative/liberal spectrum), and questions about living in an area with an active shale gas play and having a lease on one's property were not applicable to the UK context.

What is the overall level of support for shale gas development, and how does it differ between the general population of the US and the UK?

US respondents were overall much more supportive of shale gas development than UK residents (table 4). A fairly sizeable majority (59%) of US respondents support shale gas development, compared to only 44% in the UK. Some caution must be taken here; it is not that UK residents are more likely to *oppose* development; opposition levels are actually quite similar across the two study sites (27% of UK residents and 25% of US respondents oppose development). Rather, US respondents are much less likely than those from the UK to say that they do not know whether they support or oppose (17% vs 29%), raising interesting questions about the relationship between development trajectory and familiarity.

Table 4. Differences in Support/Opposition between the US and the UK.

	UK	US
Support	43.5%	58.9%
Oppose	27.4%	24.5%
Don't know	29.1%	16.6%

What is the relationship between knowledge and support and how does it differ between the general population of the US and the UK?

We conducted a simple crosstab analysis within each country to explore this question (table 5). We see a very different relationship between support and knowledge across the two study sites: *answering the knowledge question correctly is associated with increased support for development in the UK***.** Those who answered correctly are twice as likely to support shale gas

development (50.4%) as those who answered incorrectly[5] (25.3%). We also observe an important effect on 'don't know' whether to support or oppose: UK respondents who answered incorrectly or did not know were more than twice as likely than those who answered correctly to say they did not know (53% versus 20%) whether they supported or opposed shale gas development.

Table 5. Support and Knowledge, US and UK

	UK Respondents		Us Respondents	
	Answered Correctly	Did not	Answered Correctly	Did not
Support	50.4%	25.3%	61.4%	57.6%
Oppose	29.4%	22.0%	31.8%	20.8%
Don't know	20.1%	52.7%	6.8%	21.5%

UK

Pearson Chi-Square	404.4, 3df p<.001
Phi/Cramer's V (Effect size)	.325

US

Pearson Chi-Square	51.4, 3df p<.001
Phi/Cramer's V (Effect size)	.201

A very different effect is observed in the US: there is no effect on support of answering correctly versus incorrectly/don't know. We observe fairly strong support overall (about 60% of respondents), but this figure scarcely differs between those who answered correctly (61.4%) and those who did not (57.6%). Counter to what was found in the UK, answering correctly was associated with (relatively) more *opposition than* the support: 32% who answered correctly were opposed, versus 21% of those incorrectly answering. Finally, only 22% of US respondents with relatively low knowledge (answered incorrectly or stated "don't know") stated that they did not know whether they supported or opposed shale gas development. This stands in stark contrast to what was found in the UK, where over 50% of those with low knowledge in the UK stated that they did not know whether they supported or opposed development. Only 7% of US respondents

[5] We had considered disaggregating the "don't know" responses from the incorrect responses, but the response patterns vis-à-vis support/opposition were very similar, thus we chose to combine them.

who answered correctly stated that they did not know whether to support or oppose, versus 20% in the UK; in the UK, knowledge can still manifest in attitudinal uncertainty.

Discussion

Robust differences exist between the US and UK respondents. We found higher levels of knowledge (answering the screener question correctly) about the shale gas industry in the UK than in the US,, but higher levels of support in the US (opposition levels were similar across the two samples, but US respondents were much less likely than UK respondents to say that they did not know whether they supported or opposed development). Regarding the relationship between knowledge and support, we see that increased knowledge in the UK is associated with increased support, while knowledge was unrelated to support in the US. UK respondents who did not answer the knowledge question correctly were very likely to say they did not know whether they supported or opposed development—it seems eminently reasonable that those who had incorrect information or realized they did not know the answer did not express strong support or opposition. In stark contrast, more than half of the US respondents who did not answer correctly supported development.

At this point it becomes reasonable to reflect on the adequacy of the knowledge question (correctly associating hydraulic fracturing / 'fracking' with 'shale gas') as reflecting knowledge. It seems sensible that anyone with a basic working knowledge of this topic would almost certainly be able to make this basic association; therefore, it is a good proxy for (at least limited) knowledge. This simple measure reveals nothing about the process by which people become informed. . It is also possible that the "shale gas" language resonates differently across the contexts, contributing to the results. The term 'shale gas' is virtually always used when discussing hydraulic fracturing in the UK. In media coverage, the two are nearly interchangeable, even when technically inaccurate (e.g., hydraulic fracturing for coal bed methane) (Jaspal and Nerlich, 2011). In the US, Evensen et al. (2014) have noted a greater pluralism of terminology, with the term "fracking" often used to denote the entire process of shale gas development. We do not wish to over-speculate on this possibility as the "shale gas" parlance is quite recognizable in the US as well (Ashmoore et al., 2016); future research

certainly could explore the effects of experimentally varying the wording in survey instruments (Clarke et al.. 2015 did so on a US-focused study).

That US respondents are only half as likely as those from the UK to say that they do not know whether they support or oppose further development raises interesting questions about the relationship between the trajectory of shale gas development and knowledge. Setting aside the possibility that this represents a more general cultural pattern of US survey respondents being less willing to admit to lack of knowledge, this finding also could be attributed to longer more extensive history of development in the US leading to familiarity. However, Stedman et al. (2012) found the opposite (longer pattern of development correlated to lower self-assessed knowledge) in their comparisons between New York and Pennsylvania. Further, such a conclusion seems not in keeping with the finding that less knowledge is related to greater support among US respondents, nor that 72% answered the knowledge question correctly in the UK, whilst only half that number (36%) answered it correctly in the US.

In turning back to the questions motivating our research, the information deficit/educating the public model, so oft castigated in academic research, seems—even with admittedly limited data—to hold up reasonably well in the UK: simply put, those who answer the question correctly are more supportive of industry. This is the classic model promulgated by those who suggest the need to "educate the public" about risky technologies such as shale gas development, and is consistent with publically articulated national level policy around shale gas development in the UK. Several caveats are important to engage. First, as we have described, our measures of how people *become* informed are somewhat limited by the data at hand. Further research is needed in this area. In the UK, in particular, we only had data available on the readership of particular newspapers in general (rather than other potential sources of information that might have been part of concerted efforts in the UK to educate people about science in general and shale gas in particular). Given the emphasis put on educating the UK public about science and technology, research reflecting more nuance on where people receive such information is crucial. Second, the data in our study are limited in that we can only make our assessments here with single point in time information rather than conducting a longitudinal analysis or experiment where we would be able to view the effect of additional information on

knowledge and support (as did Whitmarsh et al., 2015). Again, we urge that other researchers carry forward this line of inquiry as the industry develops in both the US and the UK.

Further, consistent with our expectations emerging from the relative centralization of governance and discourse—much more concentrated and purposeful in the UK—evidence supporting the information deficit model is notably absent for US respondents, where those not answering correctly were disproportionately likely to support further development. Why does a relative lack of knowledge translate into support rather than opposition (or, more reasonably, at least uncertainty, as is seen in the UK data)? From the standpoint of the data we have available, we cannot trace the source of this difference. We might ask whether there is something qualitatively different about the nature of the information that people have access to—information perhaps with a more positive valence in the UK, as suggested by the rhetoric from the Cameron administration and related efforts to engender support. The centralized assurance found in the UK that the science around shale gas development is sound and that the technology is safe is notably absent in the US, where there is no strong central reassuring voice. Rather, we see a near cacophony of claims and counter-claims about the safety, benefits, and harms of the industry.

Finally, it is also reasonable to surmise that the previously discussed media linkage between shale gas development and jobs, economic prosperity, and energy independence resonates strongly, perhaps disproportionately so, among those relatively less knowledgeable. That US respondents who expressed low knowledge were still willing to express an opinion, and a supportive one at that, could indicate that they are disproportionately focused on potential benefits, rather than risks, of shale gas development, and that these views are not strongly tied to knowledge. Other research using this data set (*name withheld for blind review, 2016)* supports this claim, indicating that on the whole, US respondents were more likely than UK respondents to associate shale gas with positive outcomes such as cheap energy, clean energy, and energy security; UK respondents were more likely to associate shale gas with negative outcomes such as earthquakes. The source of these associations deserves further exploration with additional items that test the dimensionality of attitudes, and the source of knowledge.

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